

REMARKS

Summary of Amendments and Status of Claims

New dependent claims 15 and 16 have been added to recite a property of the gallium-nitride semiconductor substrate of their respective parent claims 1 and 2 that further distinguishes the nature of the contamination at the interface between the substrate's mirrorlike planar surface and the device-forming film directly carried by that surface.

With claims 3 and 5 being withdrawn, and claims 4, 6-10, 13 and 14 canceled,

- **claims 1, 2, 11, 12, 15 and 16**

are pending the Examiner's further consideration on the merits.

Support for New Claims 15 and 16

Table VI below paragraph [0139] of the present specification sets forth photoluminescent output for five experimental examples of GaN substrates prepared according to respective embodiments of the present invention. In the claim-support table below, Table VI is reproduced in its entirety in the two left-hand columns. Data taken from paragraph [0138] and data extrapolated from the figure, based on a claim 2 limitation, are inserted as middle rows into the table. In specification paragraph [0140], immediately following Table VI, residual metal density measured on the five example substrates at their substrate-surface/device-layer interfaces is given for each. That data is entered under the "Residual Metal Density" column in the table.

The rightmost column in the table below presents the ratio of the photoluminescence to the integer that is the base (radix) of the metal contaminant levels, when each contaminant-density level is given in terms of a 10^{10} order of magnitude.

Claims 15 & 16 Support Table

	Photoluminescence (arbitrary units)	Residual Metal Density	Photoluminescence/ Residual Metal Density 10^{10} Radix
Ex. 1	1250	2825×10^{10} atoms/cm ²	0.44
Ex. 2	1420	2279×10^{10} atoms/cm ²	0.62
Ex. 3	2350	218×10^{10} atoms/cm ²	10.8
¶ [0138]	3000*	100×10^{10} atoms/cm²	30.0
Claim 2	4400**	50×10^{10} atoms/cm²	88.0
Ex. 4	3330	79×10^{10} atoms/cm ²	42.2
Ex. 5	5800	15×10^{10} atoms/cm ²	386.7

* Taken from paragraph [0138], as explained below.

** Extrapolated, as indicated below, from the graph that is the drawing for the present specification.

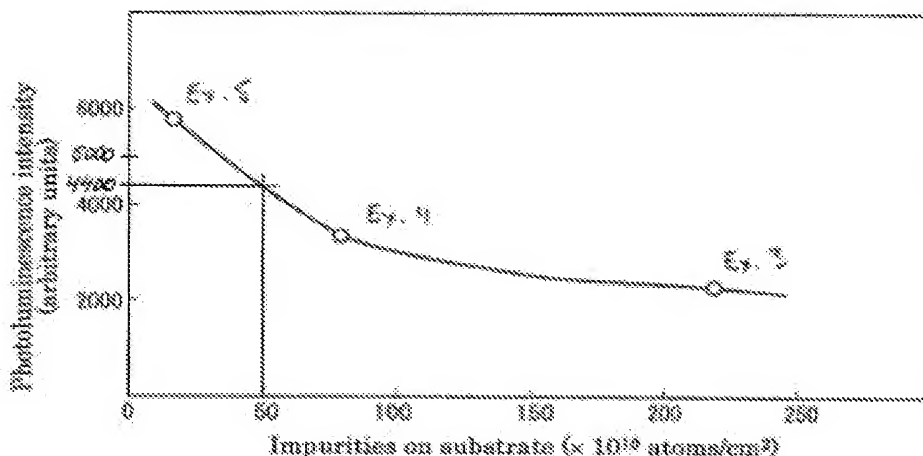
In the claim-support table above, the photoluminescence values corresponding to the maximum contaminant-density levels recited in claims 15 and 16, as quoted from their respective parent claims 1 and 2, are derived as follows.

Paragraph [0138] of the specification notes that

If the photoluminescence was 3000 or more, then that sample was usable as a light-emitting device substrate. That photoluminescence is at a metal atom density level of 100×10^{10} atoms/cm² ($= 10^{12}$ atoms/cm²), which is the *critical* contaminant-metal density.

Meanwhile, the photoluminescence that corresponds to the 5×10^{11} atoms/cm² maximum contaminant-density level that is recited in claim 2—a maximum contaminant-density level which has been recited in that claim since it was originally presented on the filing of the instant application—may be understood from the figure, also originally presented on the filing of the instant application, to be about 4400 arbitrary units, by extrapolating as indicated below.

FIGURE



Thus, with regard to claim 15, the photoluminescence given in paragraph [0138] as the value for a substrate having the critical contaminant-metal density, divided by that maximum contaminant-density level (the maximum of the range recited in claim 1), and dropping the units to take the result as unity, is $3000 \div 10 \times 10^{11} = 3 \times 10^{-9}$. Meanwhile, the photoluminescence of Example 5 divided by the contaminant-density level of the Example 5 substrate (the minimum of the range recited in claim 1), given in terms of the same order of magnitude as the unity quantity, is $5800 \div 1.5 \times 10^{11} = 38.7 \times 10^{-9}$.

Hence, the Example 5 photoluminescence, 5800, in terms of the Example 5 contaminant-density level, 15×10^{10} atoms/cm², is $38.7 \times 10^{-9} / 3 \times 10^{-9} \approx \mathbf{13 \text{ times}}$ the unity contaminant-density level, "when the ratio of the photoluminescence [3000] at the maximum contaminant-density level of 10×10^{11} atoms/cm² to said maximum contaminant-density level is taken as a standard at unity," as recited in claim 15.

And with regard to claim 16, the photoluminescence extrapolated from the figure as the value for a substrate having the maximum of the contaminant-metal density range recited in claim 2, divided by that maximum contaminant-density level, and dropping the units to take the result as unity, is $4400 \div 5 \times 10^{11} = 8.8 \times 10^{-9}$.

Hence, the Example 5 photoluminescence in terms of the Example 5 contaminant-density level is $38.7 \times 10^{-9} / 8.8 \times 10^{-9} \approx \mathbf{4.4 \text{ times}}$ the unity contaminant-density level, "when the ratio of the photoluminescence [3000] at the maximum contaminant-density level of 5×10^{11} atoms/cm² to said maximum contaminant-density level is taken as a standard at unity," as recited in claim 16.

The calculations set forth above are based upon data taken directly from the specification—and in one instance extrapolated reasonably from data tabulated and graphed in the specification. It is respectfully submitted that while claims 15 and 16 recite a distinguishing feature of the present invention—substrate photoluminescence in terms of residual metal density—in a way not originally claimed, that manner of claiming is fully supported by the parameters given in the specification.

MPEP 2163 II.A.3.(b), "New Claims, Amended Claims . . ." states

To comply with the written description requirement of 35 U.S.C. 112, para. 1, . . . each claim limitation must be expressly, implicitly, or inherently supported in the originally filed disclosure.

From the explanation detailed above, it will be appreciated that the limitations recited in claims 15 and 16 are "expressly, implicitly, or inherently supported in the originally filed disclosure," and that thus it would be clear to a person skilled in the art that the present inventors at the time the instant application was filed had possession of the subject matter recited in claims 15 and 16.

Claim Rejections – 35 U.S.C. § 103

Claims 1, 2, 11 and 12: Motoki et al. '347 in view of Ito '657

Claims 1, 2, 11 and 12 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Pat. No. 6,468,347 to Motoki et al. in view of U.S. Pat. App. Pub. No. 2003/0203657 in the name of Ito.

As stated at the top of Page 2 of its April 13, 2011 action report, the Office has withdrawn the rejections over *Motoki et al.* in combination with *Kiehlbauch et al.*

The current rejection is again over *Motoki et al.* as the primary reference. Applicants do not contest that *Motoki et al.* teaches what the Office alleges that the reference teaches. The Office, acknowledging, as previously, that *Motoki et al.* does not anticipate Applicants' invention as claimed, now relies on *Ito*, apparently on the premise that *Ito* suggests GaN as one of the materials suitable for the semiconductor layer in a semiconductor-on-insulator (SOI) wafer that can be cleaned by the *Ito* annealing method.

At the top of Page 3 of the April 13, 2011 action report, the Office insists that *Ito* is in the same field of endeavor. In making this allegation, the Office cites paragraph [0114] of *Ito*. Paragraph [0114] is the one instance in *Ito* where GaN is mentioned; otherwise the reference is entirely silent as to gallium-nitride materials, or indeed any nitride materials whatsoever. Paragraph [0114] of *Ito* states:

The present invention can be also applied to a 200 nm or less thick semiconductor layer formed on an insulating layer. The semiconductor layer may be a single layer made of Si, Ge, SiGe, SiC, C, GaAs, GaN, AlGaAs, InP, or InAs, or multiple layers thereof. For example, an Si layer is formed on an SiGe layer, or an SiGe layer is formed on an Si layer.

Although the composition of the "insulating layer" is only implied here, not expressly given—as is the case throughout the entirety of the *Ito* disclosure save for one instance—the implication is clearly that the insulating layer is silicon-based. Paragraph [0030] states, "As an SOI to be processed by the present invention," one option is to use "an SOI wafer having a crystal semiconductor layer formed on an insulating substrate such as a silica glass substrate."

Thus, if *Ito* can be said to suggest a GaN-based device at all, that device would be constituted from a GaN layer formed on a silicon-based insulating substrate. In other words, that device would be constituted from a bonded, composite wafer. Hence, a person skilled in the art wanting to produce GaN-based devices according to *Motoki et al.* while somehow taking advantage of the teachings of *Ito* would be endeavoring to discover whether the *Ito* cleaning-by-annealing method could be used to clean a *Motoki et al.* device-forming substrate, and if so, to the same low level of nickel-based impurities contamination taught in *Ito*.

It is respectfully submitted, however, that a person skilled in the art would understand that the *Ito* cleaning-by-annealing method is specifically directed to the bonded, composite SOI wafers of *Ito*, in that an art-recognized problem with such wafers is that impurities from the insulator material in the bonded wafer tend to precipitate out. Clearly this sort of difficulty would not be an issue with the GaN-based devices that *Motoki et al.* is directed to.

Hence, there is no rationale for a person skilled in the art to combine the teachings of *Ito* with those of *Motoki et al.* The Office states, in the middle of the first paragraph on Page 3 of its April 13, 2011 action report, "One of ordinary skill would strive to achieve the lowest level of metal contamination possible in order to prevent short-

circuiting effects or other layer mishaps." While the desirability of that goal is uncontestable, it does not rationalize the Office's apparent allegation that a person skilled in the art would find it predictable to combine the teachings of *Ito* with those of *Motoki et al.*

Moreover, the Office has not presented any evidence that the *Ito* cleaning-by-annealing method would successfully clean a *Motoki et al.* device-forming substrate to clear the substrate of nickel-based impurities contamination to the level taught by *Ito*.

For at least the foregoing reasons, the rejection of claims 1 and 2 over *Motoki et al.* in view of *Ito* is believed to be improper and thus overcome. Claims 11 and 12, the other pending claims that stand rejected, depend respectively from claims 1 and 2, such that their rejection is likewise believed to have been overcome.

Furthermore, it is respectfully submitted that claims 15 and 16 make clear that no other contaminants are present on the claimed film-bearing GaN substrate of their respective parent claims 1 and 2. That is, the photoluminescence recited in claims 15 and 16 is one property of the film-bearing GaN substrates of claims 1 and 2 that evidences that the presence of any other contaminants at their substrate-surface/device-layer interfaces is in effect disclaimed.

Conclusion

Accordingly, Applicants courteously urge that this application is in condition for allowance. Reconsideration and withdrawal of the rejections is requested. Favorable action by the Examiner at an early date is solicited.

Respectfully submitted,

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